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(54) **SERIES FAN**

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F04D 29/32	(2006.01)
F04D 29/60	(2006.01)

(52) **U.S. Cl.**
CPC ***F04D 19/007*** (2013.01); ***F04D 19/002*** (2013.01); ***F04D 25/166*** (2013.01); ***F04D 29/325*** (2013.01); ***F04D 29/36*** (2013.01); ***F04D 29/601*** (2013.01)

(58) **Field of Classification Search**
CPC F04D 19/007; F04D 19/002; F04D 25/166; F04D 29/325; F04D 29/36; F04D 29/601
See application file for complete search history.

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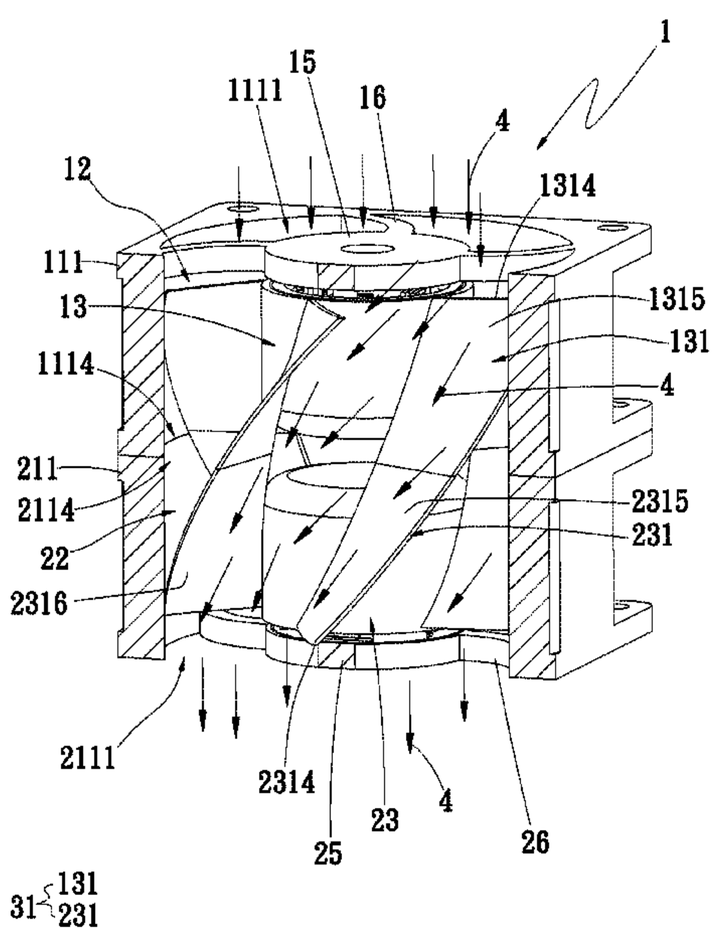
(57) **ABSTRACT**

A series fan includes a first fan and a second fan. The first fan includes a first frame body with a wind incoming side and a connection side at two sides, a first dynamic blade impeller and a first shaft seat. The first dynamic blade impeller is pivotally disposed on the first shaft seat and has first dynamic blades. The second fan includes a second frame body, a second dynamic blade impeller and a second shaft seat. Two sides of the second frame body are formed with a wind outgoing side and a mating side mated with the connection side in communication therewith. The second dynamic blade impeller is pivotally disposed on the second shaft seat and has second dynamic blades. At least one connected section of the second dynamic blade is integrally connected with at least one connection section of the first dynamic blade to form a driving blade.

10 Claims, 4 Drawing Sheets



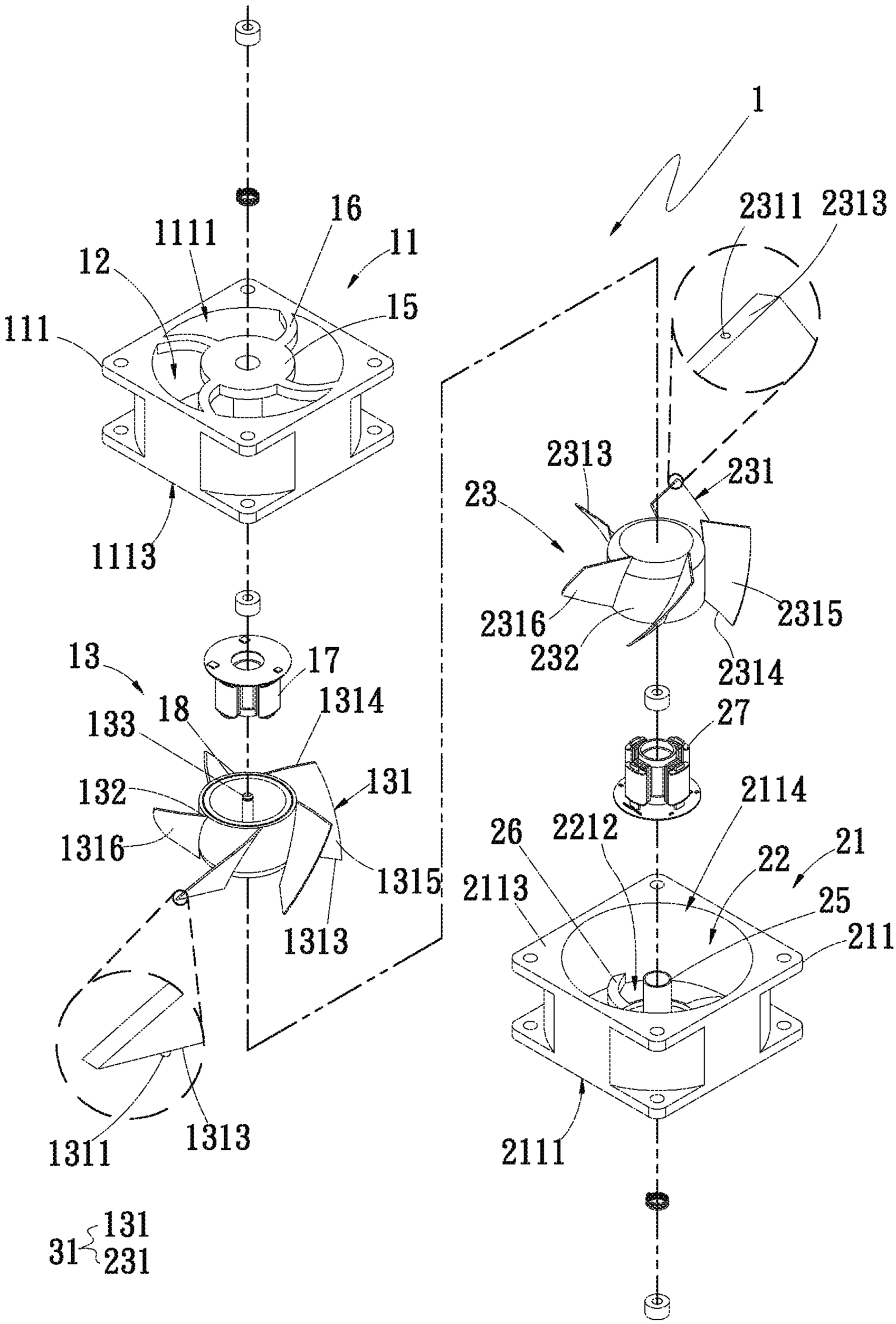

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Fig. 1

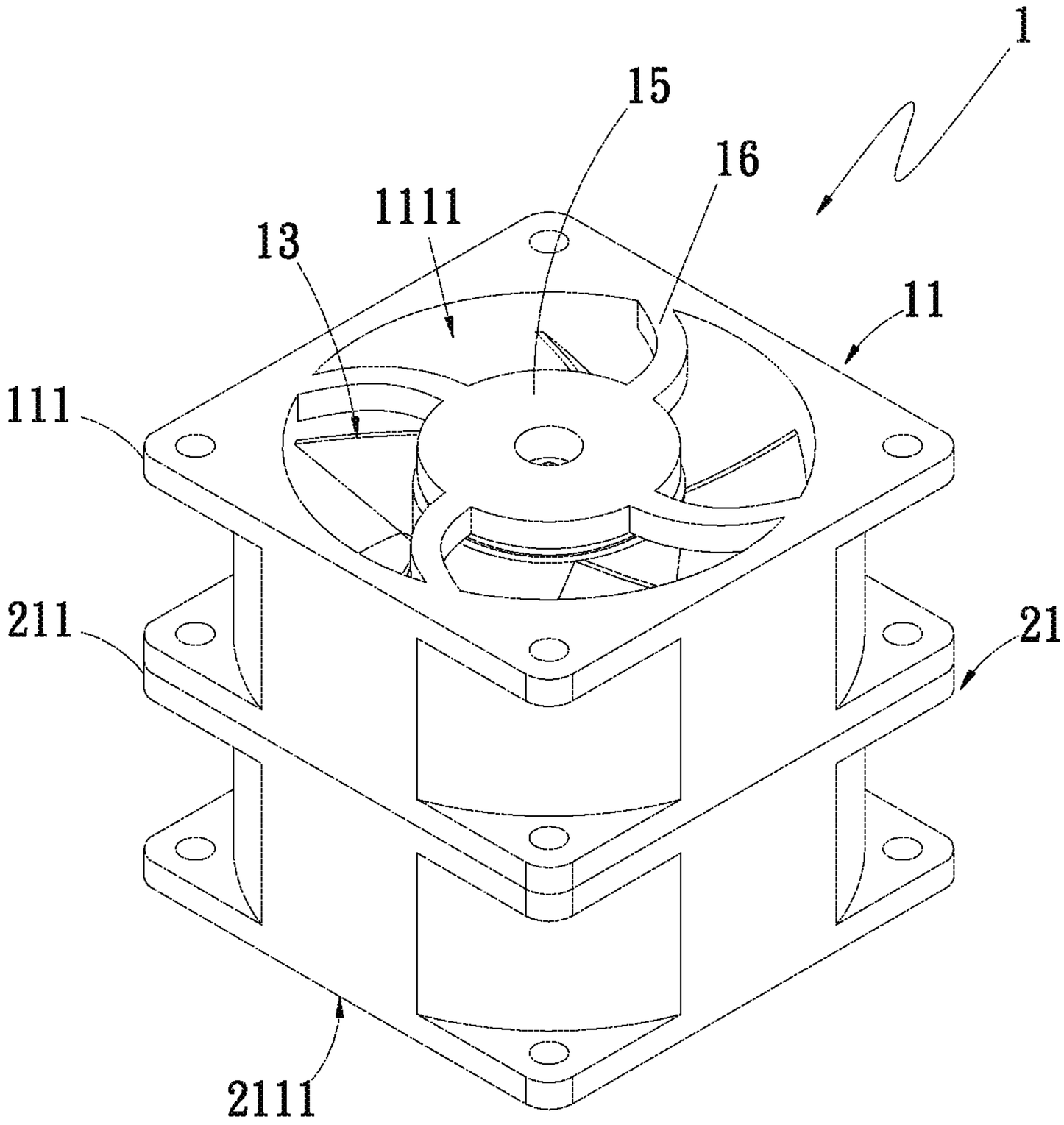

Fig. 2A

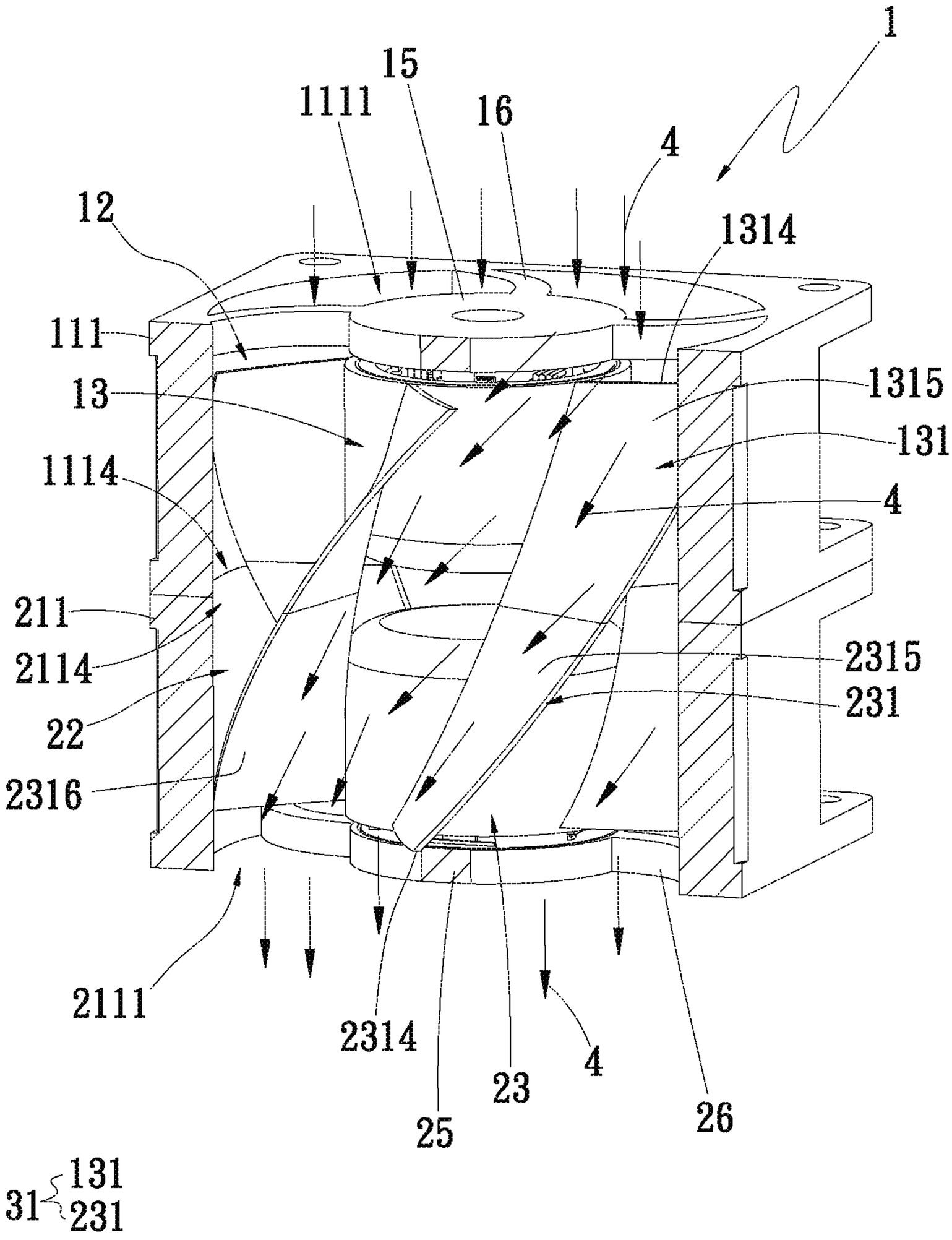
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Fig. 2B

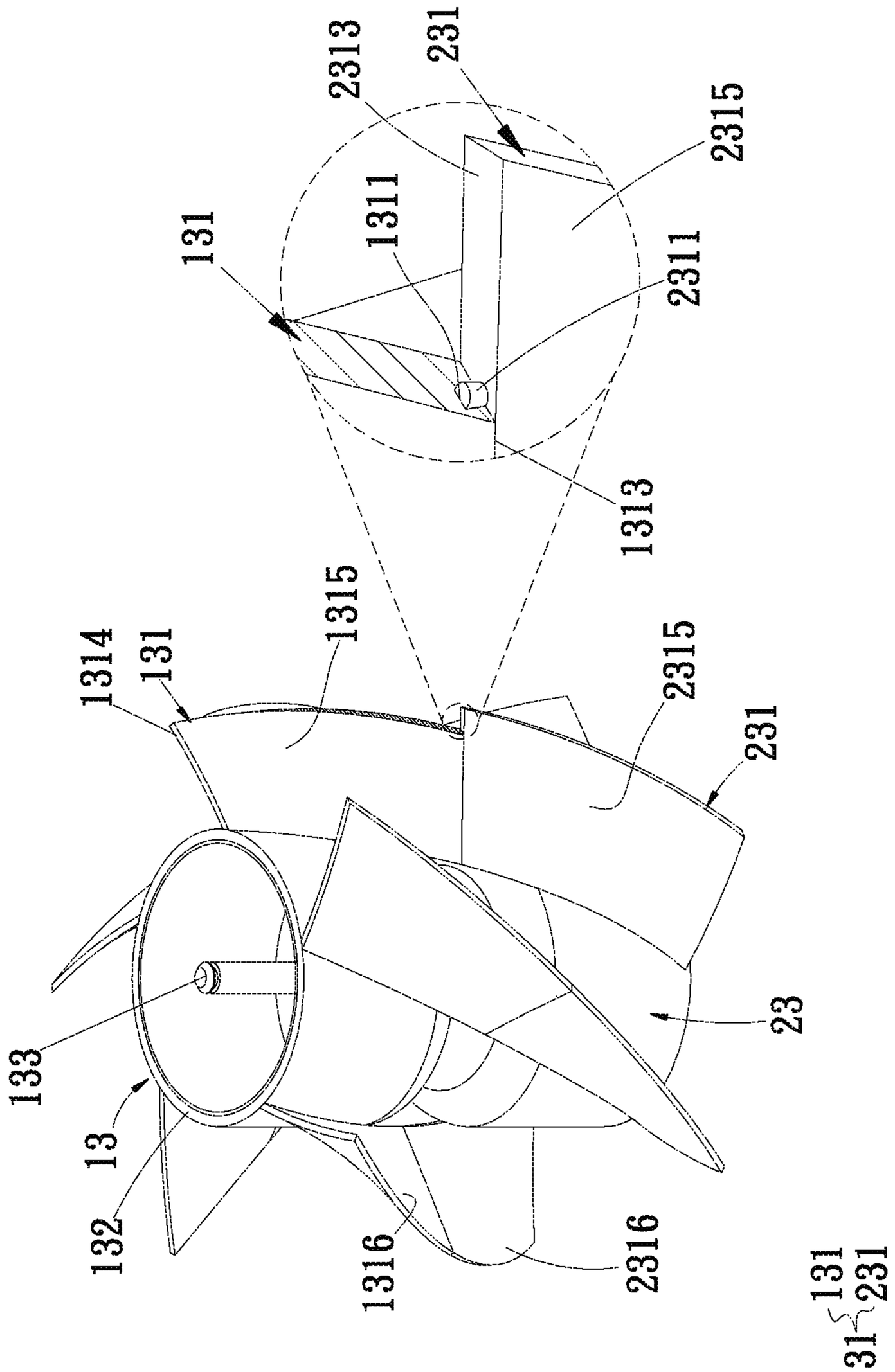
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Fig. 3

SERIES FAN

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to a series fan, and more particularly to a series fan in which two dynamic blades are connected to form a driving blade in the form of a continuous blade so as to enhance the wind pressure of the series fan.

2. Description of the Related Art

Along with the advance of sciences and technologies, the reliance of peoples on various electronic devices has been more and more increased. However, in operation, the internal components of the electronic devices (such as computers and notebooks) will generate high heat. The heat must be conducted out of the electronic devices in time. Otherwise, the internal components will be over-heated. Therefore, in most of the electronic devices, a cooling fan is often employed to actively dissipate the heat so as to keep the electronic products working within a certain operation temperature range. However, sometimes one single cooling fan can hardly provide sufficient wind force. Therefore, two or more fans are often serially assembled to form a series fan so as to provide sufficient wind force.

In a conventional series fan, a front fan and a rear fan are serially connected. The main components of the series fan include pre-dynamic blades, pre-static blades, post-static blades and post-dynamic blades, which are sequentially arranged from the wind incoming opening to the wind outgoing opening. The pre-static blades of the front fan and the post-static blades of the rear fan serve as best support components for the series fan. However, the pre-static blades of the front fan and the post-static blades of the rear fan are positioned in the middle of the series fan. Therefore, the structural supportability of the series fan in the position of the pre-dynamic blades of the front fan and the post-dynamic blades of the rear fan is relatively weak. That is, the structural supportability of the series fan at the wind incoming opening and the wind outgoing opening is weaker.

When the conventional series fan is fixed in the electronic device, the electronic device is assembled with the wind incoming opening or wind outgoing opening of the series fan. However, the pre-dynamic blades and the post-dynamic blades at the wind incoming opening and the wind outgoing opening are not supported by any support structure. In this case, the vibration value of the entire series fan is often increased to affect the stability of the system of the entire series fan.

Moreover, the pre-dynamic blades and the post-dynamic blades at the wind incoming opening and the wind outgoing opening are in an open state. In consideration of security, a protection web is often additionally mounted in the positions of the wind incoming opening and the wind outgoing opening of the series fan to achieve protection effect. This causes increase of cost of material and working time of the entire series fan.

Furthermore, when the conventional series fan is disposed in the electronic device, the corresponding installation height of the series fan is fixed and limited. Therefore, the total thickness of the series fan is limited. That is, the design of the dynamic and static blades of the series fan is limited by the arrangement of the middle motors and the pre-dynamic blades and the post-dynamic blades of the front and rear fans so that the total height and size of the series fan are designed in a fixed proportion. Relatively, the pre-dynamic blades and the post-dynamic blades have fixed sizes and proportions. In addition, the pre-dynamic blades and the post-dynamic blades are limited by the fixed sizes and arrangement of the intermediate components, (that is, the pre-static blades and the post-static blades) so that the pre-dynamic blades and the post-dynamic blades can only independently rotate as two separate components and cannot be made in the form of one single continuous blade. As a result, when the pre-dynamic blades and the post-dynamic blades with fixed sizes respectively pressurize the airflow flowing into the series fan, before the airflow is pressurized, the airflow is thrown out by the respective blades, (that is, the pre-dynamic blades and the post-dynamic blades). Therefore, the pressurizing time of the pre-dynamic blades and the post-dynamic blades for the airflow flowing into the series fan is too short so that the wind pressure of the entire series fan cannot be effectively enhanced.

SUMMARY OF THE INVENTION

It is therefore a primary object of the present invention to provide a series fan, which has enhanced wind pressure effect.

To achieve the above and other objects, the series fan of the present invention includes a first fan and a second fan. The first fan includes a first frame body, a first dynamic blade impeller and a first shaft seat. Two sides of the first frame body are respectively formed with a wind incoming side and a connection side. The first shaft seat is disposed at a center of the wind incoming side. A first static blade is disposed between the first shaft seat and inner circumference of the first frame body. The first dynamic blade impeller is pivotally disposed on the first shaft seat and has multiple first dynamic blades. Each first dynamic blade has at least one connection section. The second fan includes a second frame body, a second dynamic blade impeller and a second shaft seat. Two sides of the second frame body are respectively formed with a wind outgoing side and a mating side mated with the connection side in communication therewith. The second shaft seat is disposed at a center of the wind outgoing side. A second static blade is disposed between the second shaft seat and inner circumference of the second frame body. The second dynamic blade impeller is pivotally disposed on the second shaft seat and has multiple second dynamic blades. Each second dynamic blade has at least one connected section. The connected section of the second dynamic blade is integrally connected with the connection section of the first dynamic blade to form a driving blade. The first fan is upside-down placed and serially connected with the second fan. By means of the above design of the series fan of the present invention, the wind pressure of the entire series fan is effectively enhanced.

In the above series fan, the connection side has a first opening. The first dynamic blade impeller has a first hub and a first shaft. One end of the first shaft is fixedly disposed at a center of the first hub. The other end of the first shaft is pivotally disposed in the first shaft seat. The multiple first dynamic blades are radially disposed along outer circumference of the first hub. Each first dynamic blade has a blade front edge and a blade tail edge. The connection section is disposed on the blade front edge. The blade front edge is protruded from, recessed into or flush with the first opening. The blade tail edge is positioned in the wind incoming side.

In the above series fan, the mating side has a second opening in communication with the first opening. The sec-

ond dynamic blade impeller has a second hub and a second shaft. One end of the second shaft is fixedly disposed at a center of the second hub. The other end of the second shaft is pivotally disposed in the second shaft seat. The multiple second dynamic blades are radially disposed along outer circumference of the second hub. Each second dynamic blade has a blade front edge and a blade tail edge. The connected section is disposed on the blade front edge of the second dynamic blade. The blade front edge of the second dynamic blade is protruded from the second opening into the first opening, flush with the second opening or recessed into the second opening. The blade tail edge of the second dynamic blade is positioned in the wind outgoing side.

In the above series fan, each first dynamic blade has a first upper surface and a first lower surface and each second dynamic blade has a second upper surface and a second lower surface. The first upper surface is connected with the second upper surface to form a continuous upper surface. The first lower surface is connected with the second lower surface to form a continuous lower surface.

In the above series fan, the connection section and the connected section are raised structure and recessed structure in adaptation to the raised structure or any other connection structures in adaptation to each other, such as recessed structure and raised structure in adaptation to the recessed structure, screw structures, insertion structures, adhesion structures or welding structures.

In the above series fan, the connection side of the first frame body is mated with the mating side of the second frame body by means of engagement, locking, insertion, adhesion, slide rail or latching.

In the above series fan, the connection side has a first opening. A first flow way is defined between the wind incoming side and the first opening. The first flow way is in communication with the wind incoming side and the first opening.

In the above series fan, the mating side has a second opening in communication with the first opening. A second flow way is defined between the wind outgoing side and the second opening. The second flow way is in communication with the wind outgoing side and the second opening. The first and second flow ways are in communication with each other to together form an airflow guide passage. The driving blade is positioned in the airflow guide passage.

In the above series fan, the first dynamic blade impeller and the second dynamic blade impeller are formed by means of integral injection molding.

BRIEF DESCRIPTION OF THE DRAWINGS

The structure and the technical means adopted by the present invention to achieve the above and other objects can be best understood by referring to the following detailed description of the preferred embodiments and the accompanying drawings, wherein:

FIG. **1** is a perspective exploded view of a preferred embodiment of the present invention;

FIG. **2**A is a perspective assembled view of the preferred embodiment of the present invention;

FIG. **2**B is a sectional view of the preferred embodiment of the present invention, showing that the airflow is continuously pressurized by the driving blades; and

FIG. **3** is a perspective view of the preferred embodiment of the present invention, showing the connection form of the connection section and the connected section, in which the connection section and the connected section are raised structure and recessed structure in adaptation to the raised structure.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Please refer to FIGS. **1**, **2**A and **2**B. The series fan **1** of the present invention includes a first fan **11** and a second fan **21**. The first fan **11** includes a first frame body **111**, a first dynamic blade impeller **13** and a first shaft seat **15**. Two sides of the first frame body **111** are respectively formed with a wind incoming side **1111** and a connection side **1113**. The connection side **1113** has a first opening **1114**. The first opening **1114** and the wind incoming side **1111** define therebetween a first flow way **12** in communication with the wind incoming side **1111** and the first opening **1114**. The wind incoming side **1111** serves to guide external airflow **4** to flow into the first flow way **12** of the first frame body **111**. The airflow is then guided out by the first opening **1114** to flow into the second fan **21**.

The first shaft seat **15** is disposed at the center of the wind incoming side **1111**. A first static blade **16** is disposed between the first shaft seat **15** and inner circumference of the first frame body **111**. The first static blade **16** is positioned at the wind incoming side **1111**. In this embodiment, the first static blade **16** is a rib. Two ends of the first static blade **16** are, but not limited to, respectively connected with outer circumference of the first shaft seat **15** and the inner circumference of the first frame body **111** for illustration purposes. In practice, the first static blade **16** can be a blade. The first dynamic blade impeller **13** is pivotally disposed on the first shaft seat **15** and positioned in the first flow way **12**. The first dynamic blade impeller **13** has multiple first dynamic blades **131**, a first hub **132**, a stator **17** and a first shaft **133**. One end of the first shaft **133** is fixedly disposed at the center of the first hub **132**. The other end of the first shaft **133** is pivotally disposed in the first shaft seat **15**. The multiple first dynamic blades **131** are radially disposed along outer circumference of the first hub **132**. The stator **17** of the first dynamic blade impeller **13** is fitted around a bearing cup of the first shaft seat **15**. A magnetic member **18** (such as a magnet) is disposed on inner circumference of the first hub **132**. The stator **17** and the magnetic member **18** are magnetized with each other by induction.

Each first dynamic blade **131** has a blade front edge **1313**, a blade tail edge **1314**, a first upper surface **1315**, a first lower surface **1316** and at least one connection section **1311**. The blade front edge **1313** and the blade tail edge **1314** of the first dynamic blade **131** are respectively positioned in the first opening **1114** of the connection side **1113** and the wind incoming side **1111**. The blade front edge **1313** can be selectively protruded from, recessed into or flush with the first opening **1114**. The connection section **1311** is disposed on the blade front edge **1313** of the first dynamic blade **131**.

The second fan **21** includes a second frame body **211**, a second dynamic blade impeller **23** and a second shaft seat **25**. Two sides of the second frame body **211** are respectively formed with a wind outgoing side **2111** and a mating side **2113**. The mating side **2113** is mated with the connection side **1113** in communication therewith. The connection side **1113** of the first frame body **111** is mated with the mating side **2113** of the second frame body **211** by means of engagement, locking, insertion, adhesion, slide rail or latching, whereby the first fan **11** is upside-down placed and serially connected with the second fan **21** to form the series fan **1**.

The mating side **2113** has a second opening **2114**. The second opening **2114** serves to further guide the airflow flowing from the first opening **1114**, whereby the airflow can continuously flow. The second opening **2114** and the wind outgoing side **2111** define therebetween a second flow way **22** in communication with the wind outgoing side **2111** and the first and second openings **1114**, **2114**. The first and second flow ways **12**, **22** communicate with each other to together form an airflow guide passage. The wind outgoing side **2111** serves to discharge the airflow **4**, which is boosted (pressurized) in the airflow guide passage so as to forcedly dissipate the heat generated by a heat generation component (such as a central processing unit or graphics processing unit).

The second shaft seat **25** is disposed at the center of the wind outgoing side **2111**. A second static blade **26** is disposed between the second shaft seat **25** and inner circumference of the second frame body **211**. In this embodiment, the second static blade **26** is a rib positioned at the wind outgoing side **2111**. Two ends of the second static blade **26** are, but not limited to, respectively connected with outer circumference of the second shaft seat **25** and the inner circumference of the second frame body **211**. In practice, the first and second static blades **16**, **26** can be adjusted into same structure (such as both are ribs) or different structures (such as one is a rib, while the other is a static blade) according to the design requirement of the boosting or entire supportability of the series fan **1**. The first and second static blades **16**, **26** are respectively disposed in the wind incoming side **1111** and the wind outgoing side **2111** of the series fan **1** so that the supporting strength of the entire structure of the series fan **1** is effectively enhanced. Also, the vibration of the entire series fan **1** can be avoided. Moreover, the first and second static blades **16**, **26** serve to shield and protect the first and second dynamic blade impellers **13**, **23** so as to effectively improve the shortcoming of the conventional series fan that a protection web must be additionally arranged to cause increase of cost of material and working time.

The second dynamic blade impeller **23** is pivotally disposed on the second shaft seat **25** and positioned in the second flow way **22**. The second dynamic blade impeller **23** has multiple second dynamic blades **231**, a second hub **232**, a stator **27** and a second shaft (not shown). One end of the second shaft is fixedly disposed at the center of the second hub **232**. The other end of the second shaft is pivotally disposed in the second shaft seat **25**. The stator **17** is fitted around a bearing cup of the second shaft seat **25**. A magnetic member (such as a magnet, not shown) is disposed on inner circumference of the second hub **232**. The stator **17** and the magnetic member are magnetized with each other by induction. The first hub **132** and the second hub **232** are upside-down arranged.

The multiple second dynamic blades **231** are radially disposed along outer circumference of the second hub **232**. Each second dynamic blade **231** has a blade front edge **2313**, a blade tail edge **2314**, a second upper surface **2315**, at least one connected section **2311** and a second lower surface **2316**. The blade front edge **2313** and the blade tail edge **2314** are respectively positioned in the second opening **2114** of the mating side **2113** and the wind outgoing side **2111**. The blade front edge **2313** of the second dynamic blade **231** can be selectively protruded from the second opening **2114** into the first opening **1114** or flush with (or recessed into) the second opening **2114**. The connected section **2311** is disposed on the blade front edge **2313** of the second dynamic blade **231**. In this embodiment, the connection section **1311** of the first dynamic blade **131** and the connected section **2311** of the second dynamic blade **231** are raised structure and recessed structure in adaptation to the raised structure for illustration purposes. That is, the connection section **1311** of the first dynamic blade **131** is a boss body, while the connected section **2311** of the second dynamic blade **231** is a dent, which is connected with the boss body. Accordingly, the connection sections **1311** of the multiple first dynamic blades **131** and the connected sections **2311** of the multiple second dynamic blades **231** are integrally connected to form multiple driving blades **31** in a continuous blade form. In addition, the first upper surface **1315** is connected with the second upper surface **2315** without any gap in the junction between the first upper surface **1315** and the second upper surface **2315** so as to form a continuous upper surface. The first lower surface **1316** is connected with the second lower surface **2316** without any gap in the junction between the first lower surface **1316** and the second lower surface **2316** so as to form a continuous lower surface.

Please refer to FIGS. **1** and **2**B. When the series fan **1** operates, the first and second dynamic blade impellers **13**, **23** will synchronously rotate. The multiple driving blades **31** in the continuous blade form in the airflow guide passage will guide the external airflow **4** to axially pass through the wind incoming side **1111** into the first flow way **12** of the airflow guide passage. After the airflow **4** is guided in by the blade tail edges **1314** of the first dynamic blades **131** of the multiple driving blades **31**, the multiple first dynamic blades **131** will pressurize the airflow **4** to flow along the first upper surfaces **1315** in a direction to the blade front edges **1313**. At this time, the pressurized airflow **4** flows to the blade front edges **1313** of the first dynamic blades **131** to further continuously flow to the second upper surface **2315**, whereby the second dynamic blades **231** in the second flow way **22** further pressurizes the airflow **4**. The further pressurized airflow **4** flows along the second upper surfaces **2315** in a direction to the blade tail edges **1314**. Then the airflow **4** is downward thrown out (flow out) at a certain speed to pass through the second static blade **26** to outer side of the wind outgoing side **2111**.

In another embodiment, the connection section **1311** and the connected section **2311** are selected from a group consisting of raised structure and recessed structure in adaptation to the raised structure (as shown in FIG. **3**), screw structures, insertion structures, adhesion structures and welding structures (connected by means of welding).

In a modified embodiment, the first hub **132** of the first dynamic blade impeller **13** and the multiple first dynamic blades **131** thereon and the second hub **232** of the second dynamic blade impeller **23** and the multiple second dynamic blades **231** thereon are formed by means of integral injection molding.

According to the above design, the multiple first and second dynamic blades **131**, **231** of the series fan **1** of the present invention are integrally connected to form multiple driving blades **31** in a continuous blade form.

In this case, the airflow **4** can be continuously pressurized by the first and second dynamic blades **131**, **231** of the multiple driving blades **31** in the airflow guide passage so as to effectively greatly enhance the wind pressure of the entire series fan **1**.

The present invention has been described with the above embodiments thereof and it is understood that many changes and modifications in such as the form or layout pattern or practicing step of the above embodiments can be carried out

without departing from the scope and the spirit of the invention that is intended to be limited only by the appended claims.

What is claimed is:

1. A series fan comprising:

a first fan including a first frame body, a first dynamic blade impeller and a first shaft seat, two sides of the first frame body being respectively formed with a wind incoming side and a connection side, the first shaft seat being disposed at a center of the wind incoming side, a first static blade being disposed between the first shaft seat and inner circumference of the first frame body, the first dynamic blade impeller being pivotally disposed on the first shaft seat, the first dynamic blade impeller having multiple first dynamic blades, each first dynamic blade having at least one connection section; and

a second fan including a second frame body, a second dynamic blade impeller and a second shaft seat, two sides of the second frame body being respectively formed with a wind outgoing side and a mating side, the mating side being mated with the connection side in communication therewith, the second shaft seat being disposed at a center of the wind outgoing side, a second static blade being disposed between the second shaft seat and inner circumference of the second frame body, the second dynamic blade impeller being pivotally disposed on the second shaft seat, the second dynamic blade impeller having multiple second dynamic blades, each second dynamic blade having at least one connected section, the connected section of the second dynamic blade being integrally connected with the connection section of the first dynamic blade to form a driving blade, the first fan being upside-down placed and serially connected with the second fan.

2. The series fan as claimed in claim **1**, wherein the connection side has a first opening, the first dynamic blade impeller having a first hub and a first shaft, one end of the first shaft being fixedly disposed at a center of the first hub, the other end of the first shaft being pivotally disposed in the first shaft seat, the multiple first dynamic blades being radially disposed along outer circumference of the first hub, each first dynamic blade having a blade front edge and a blade tail edge, the connection section being disposed on the blade front edge, the blade front edge being protruded from, recessed into or flush with the first opening, the blade tail edge being positioned in the wind incoming side.

3. The series fan as claimed in claim **2**, wherein the mating side has a second opening in communication with the first opening, the second dynamic blade impeller having a second hub and a second shaft, one end of the second shaft being fixedly disposed at a center of the second hub, the other end of the second shaft being pivotally disposed in the second shaft seat, the multiple second dynamic blades being radially disposed along outer circumference of the second hub, each second dynamic blade having a blade front edge and a blade tail edge, the connected section being disposed on the blade front edge of the second dynamic blade, the blade front edge of the second dynamic blade being protruded from the second opening into the first opening, flush with the second opening or recessed into the second opening, the blade tail edge of the second dynamic blade being positioned in the wind outgoing side.

4. The series fan as claimed in claim **1**, wherein each first dynamic blade has a first upper surface and a first lower surface and each second dynamic blade has a second upper surface and a second lower surface, the first upper surface being connected with the second upper surface to form a continuous upper surface, the first lower surface being connected with the second lower surface to form a continuous lower surface.

5. The series fan as claimed in claim **1**, wherein the connection section and the connected section are selected from a group consisting of raised structure and recessed structure in adaptation to the raised structure, recessed structure and raised structure in adaptation to the recessed structure, screw structures, insertion structures and adhesion structures.

6. The series fan as claimed in claim **1**, wherein the connection section and the connected section are integrally connected with each other by means of welding.

7. The series fan as claimed in claim **1**, wherein the connection side of the first frame body is mated with the mating side of the second frame body by means of engagement, locking, insertion, adhesion, slide rail or latching.

8. The series fan as claimed in claim **1**, wherein the connection side has a first opening, a first flow way being defined between the wind incoming side and the first opening, the first flow way being in communication with the wind incoming side and the first opening.

9. The series fan as claimed in claim **8**, wherein the mating side has a second opening in communication with the first opening, a second flow way being defined between the wind outgoing side and the second opening, the second flow way being in communication with the wind outgoing side and the second opening, the first and second flow ways being in communication with each other to together form an airflow guide passage, the driving blade being positioned in the airflow guide passage.

10. The series fan as claimed in claim **1**, wherein the first dynamic blade impeller and the second dynamic blade impeller are formed by means of integral injection molding.

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